Global Deep Blue Aerosol Climatology from SeaWiFS in Comparison to MODIS and MISR: Preliminary Evaluation

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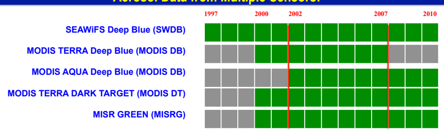
Background

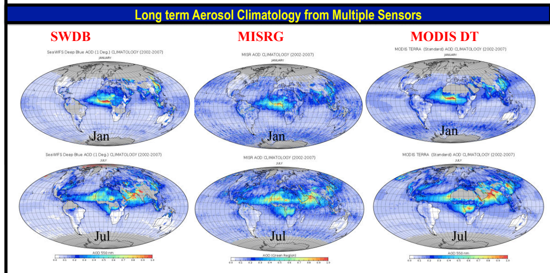
Aerosols play a key role in the Earth's radiation balance and global climate. Aerosol measurements are generally sparse over land regions and satellites usually have difficulty in retrieving aerosol over bright surface regions. The Deep Blue (DB) algorithm offers a unique way to narrow these gaps and improves our understanding of satellite measurements over such surface regions. There are large uncertainties in the aerosol products from multiple sensors due to clouds, varying surface albedo, retrieval methods. This study examines the long term aerosol SeaWiFS DB data along with other sensors to understand the aerosols over land and ocean.

Aerosol Data from Multiple Sensors:



Sensors	Satellites	Resolution	Algorithm/Filters	Characteristics	Remarks
SeaWIFS V002	OrbView-2	13.5 km	Deep Blue (land and Ocean, vegetated land), Ocean, 550nm, 510, 670, 865 nm QF (Land)=3 QF (Ocean)=2,3, Filtered for clouds, sea ice, surface snow/ice; Cells not filtered are reset to fill value	Cross-tracking scanning Radiometer, 8 spectral bands, Tilt capability to avoid Sun glint in the tropics	No IR bands for Cloud screening. Limited spectral range, need to consider Solar/ Lunar views
MISR V.31	Terra	17.6 km	Green band (550 nm),	9 cameras, 4 spectral channels, Continuous daylight swath acquisition.	Equator crossing time 10:30 LT
MODIS V.5.1	Aqua and Terra	~10 km	Dark Target (DT, ocean and land) QA scale (land)=>0, QA scale=3 DB uses 412nm,470nm, 550nm, 650nm	DT screen out cloud, water, snow, Discard brightest 50% and darkest of 20% pixels	Spectral relationship to avoid residual surface effects.

Long term Aerosol Climatology from Multiple Sensors



AOD anomalies for January 2007 from SWDB Mean Climatology (1998-2010)

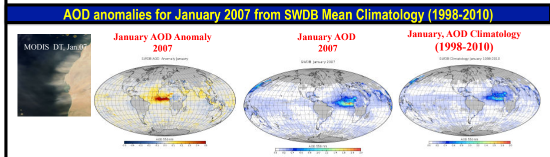
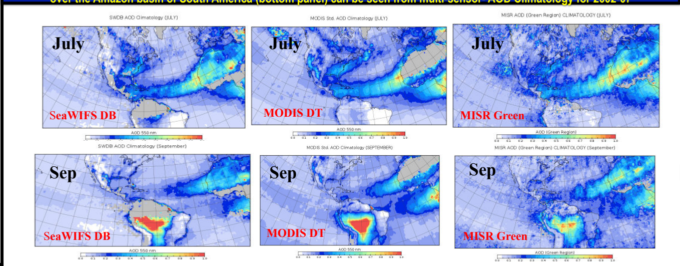


Figure (left) shows the west coast of northern Africa range in 2007 with a dust storm. Enhanced positive anomalies of AOD for 2007, actual AOD for 2007 and its long term climatology for January, are shown in the above figures. Extensive agricultural burning take place during this period over the northern Africa and south of Sahel in addition to a series of outbreaks of dust events. These plumes blew off hundreds of kilometers of coastline over the Atlantic and the nearby Canary Islands and Cape Verde.

Objectives

The objective of this study is to develop a long term aerosol climatology from 13 years of DB aerosol products from SeaWiFS v002 [1998-2010] and compare them to similar climatology made from MISR [2000-2010], MODIS Terra [2000-2007] and Aqua [2002-2010] based on Dark Target and Deep Blue algorithms to better understand the spatial, seasonal, and interannual variation of aerosol over land and ocean. This study also explores regional and global trends in terms of anomalies based on climatology derived from daily 0.5°×0.5° and 1°×1° SeaWiFS DB (SWDB) data. Since sampling can be an issue for constructing such climatology, this study looks into issues such as tilting effect, seasonal cloud-aerosol correlation and quality weighted aggregation to better understand the SeaWiFS in relation to other sensors such as MODIS and MISR. As a case study, desert regions are examined by comparing their monthly anomalies from aerosol climatology for 2002-2007.

Persistent 'Aerosol Pollution trunk ' in summer across the Ocean to US and Caribbean (top panel) and 'funnel shaped aerosol' loading over the Amazon basin of South America (bottom panel) can be seen from multi-sensor- AOD Climatology for 2002-07



SWDB and MODIS compliment each other by filling aerosol data

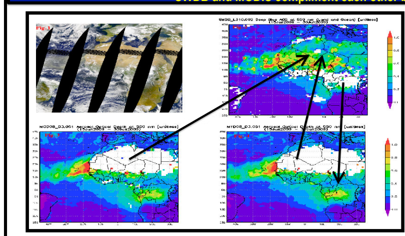
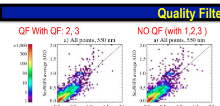


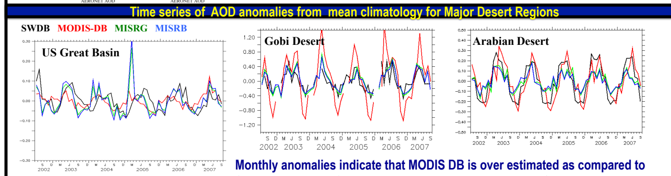
Figure 1 depicts dust immediately off the coast of West Africa and also an extended plume transport over the Atlantic, captured by SeaWiFS (Fig. 2) and MODIS (Fig. 3, 4) for the period of 15-30th June 2009. SeaWiFS has better coverage of the North African desert comparing to MODIS Dark Target that cannot measure over bright surface.

Quality Filtered AOD over Ocean is better correlated with AERONET



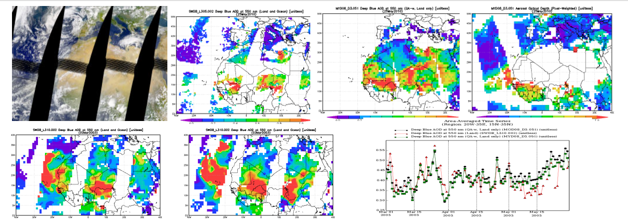
When QA =1 data is removed, the scatter gets smaller (left panel), with a lot of outlaying points removed. This can be more legible for various stations in summer.

Time series of AOD anomalies from mean climatology for Major Desert Regions



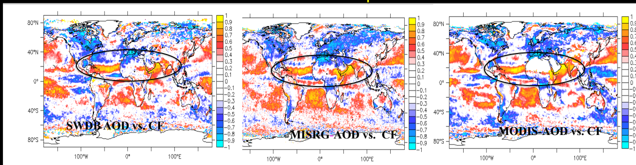
Monthly anomalies indicate that MODIS DB is over estimated as compared to SWDB over most of the Major desert regions except the US great basin.

Sampling Issues with Tilting Effect



SeaWiFS, mainly the ocean-color measuring sensor, tilts +20 or -20 deg along the track to avoid sun glint from the sea surface, mainly in equatorial areas. Depending on the season, this data-voided area can be located to the north or south of the equator. Going into mid-May, the tilt-changing regions are in desert areas, thus significantly reducing the number of observations comparing to non-tilting MODIS. The time-series plot reflects a deviation of SWDB from MODIS DB over Northern Africa starting mid May.

CLOUD –AOD interaction- Spatial Correlation



Figures depict the spatial correlation between monthly climatology of cloud fraction and AOD from multiple sensors based on 2002-2010 data. The correlation has some strong seasonal signatures, which are embedded in the plot.

Anomaly Correlations from multi-sensor-Regional Focus

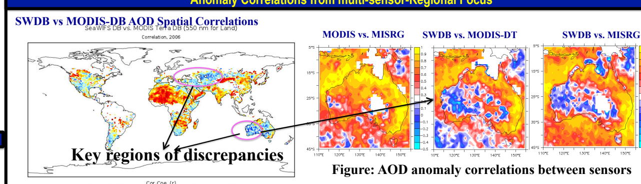


Figure: AOD anomaly correlations between sensors

Figures: Spatial Correlation of SWDB and MODIS DB AODs for land (left) and anomaly correlation of AOD for SWDB, MODIS and MISR focusing Australia (right). Here SWDB AOD (v002) anomalies have notable negative or zero correlation with that from both MODIS and MISR, at the same time MODIS and MISR AOD anomalies are varying nearly in the same positive direction. The anomaly correlations are expected to be better with the upcoming SWDB version (SWDB v003).

Summary

In general, SWDB aerosols (v002) are comparable with MISR and MODIS Dark Target for land and ocean and provide a long term aerosol climatology over the globe especially arid regions. Notable uncertainties with aerosol variations can be seen over Australia and the northern Asian regions. Cloud fraction and AOD correlation from multi-sensor climatology provides strong signatures over the Atlantic, Indian ocean and south Asia. The new version of the data (SWDB v003) is expected to provide a high quality long term aerosols from 1997 to 2010.